ÖZGÜN ARAŞTIRMA ORIGINAL RESEARCH

Med J SDU / SDÜ Tıp Fak Derg ▶ 2019:26(2):131-140 doi: 10.17343/sdutfd.417891

POSTOPERATIVE MORTALITY FOLLOWING CIVILIAN FIREARMS INJURY DURING WAR: A RETROSPECTIVE COHORT STUDY

SAVAŞ SIRASINDA SİVİL ATEŞLİ SİLAH YARALANMALARINI TAKİBEN ORTAYA ÇIKAN MORTALİTE: RETROSPEKTIF KOHORT ARAŞTIRMA

Menekşe OKŞAR, Çağla B. AKKURT, Selim TURHANOĞLU

Department of Anesthesiology and Reanimation, Mustafa Kemal University, 31100 Hatay, Turkey

Cite this article as: Okşar M, Akkurt ÇB, Turhanoğlu S. Postoperative mortality following civilian firearms injury during war: A retrospective cohort study. Med J SDU 2019; 26(2): 131-140.

Öz

Amaç

Bu çalışma savaş yaralanması nedeni ile ameliyat edilen hastalar arasında, cerrahi grupların sınıflandırmasını yaralanma şiddetinin yerine kullanarak, mortaliteyi etkileyen faktörleri tanımlamayı amaçlamaktadır.

Gereç ve Yöntem

Bu Türkiye'de bir üçüncü basamak üniversite hastanesinde 2011 ve 2014 yılları arasında ameliyata alınan hastalarda yapılan retrospektif bir çalışmadır. Tüm hastalar ateşli silah yaralanması nedeni ile ameliyata alınmış ve ASA skorları I–II idi. Yaralanmanın şiddetini ve hastanın son durumunu (sağ kalım veya ölüm) saptamak için cerrahinin tipi ve bununla ilişkili anestezi işlemine dayalı bir derecelendirme sistemi-Türkiye'de Sağlık Uygulamaları Tebliğinde tanımlandığı şekli ile-kullanıldı.

Bulgular

Şifa ile taburcu olanların hastane süreleri ölenlerden anlamlı dercede daha uzundu [medyan (min-maks.) olarak sırası ile 12 (0-559).ve 7.5(0-468) gün]. Hastalar altı kategorik cerrahi gruba (A2, A3, B, C, D, ve E) dağılmıştı. Tüm mortalite %11.3 idi ancak A2, C, ve D gruplarında hastaların sırası ile %8.1, %40.3 ve %40.3'ü, ve şifa-sağ kalım yine A2, C, D grup hastalarda sırası ile %2.4, %54.1, %25.8 oranında idi. Hastanın son durumunu etkileyen bağımsız değişkenlerin cinsiyet, yaş ve cerrahi gruplardan A2, C ve D için katsayıları anlamlı idi.

Sonuç

Cerrahi operasyon kategorileri ve sivil ateşli silah yaralanmaları arasında bir ilişki olduğu gözükmektedir, Dahası, modelimizdeki cerrahi grupları ile ilişkili katsayılar benzer populasyonlarda mortalite riskini tahmin etmeye yardımcı olabilir.

Anahtar kelimeler: Ateşli silah yaralanması, postoperatif mortalite, savaş yaralanması

Abstract:

Objective

This study aims to identify factors affecting mortality following surgery for civilian firearms injuries using surgical classification as a surrogate marker of injury severity.

Material and Methods

This was a retrospective study of patients who underwent surgery at a tertiary university hospital in Tur-

İletişim kurulacak yazar/Corresponding author: menekseoksar@gmail.com

Müracaat tarihi/Application Date: 23.04.2018 • **Kabul tarihi/Accepted Date:** 25.04.2018

key between 2011 and 2014. All patients had sustained firearms injury and had an American Society of Anesthesiologists score of I-II. A grading system defined by the Communiqué on Health Practices in Turkey was used based on the surgery type and anesthetic procedure to determine the severity of injury and its relation with patient outcome (survival or death).

Results
The median duration of hospital stay of patients who were discharged post healing was significantly longer than those who died [12 (0–559).vs 7.5 (0–468) days, respectively]. Overall mortality was 11.3%; however, the mortality of patients was 8.1%, 40.3%, and 40.3% in groups A2, C, and D, respectively. Healing in groups A2, C, and D was 2.4%, 54.1% and 25.8%, respectively. Independent variables affecting the coefficient of patient discharge status for sex, age, and surgical groups A2, C, and D were found to be significant.

Conclusion
There was an association between the surgical groups and the firearms injuries sustained by civilians. Moreover, the coefficients associated with surgical group in our model may help predict the mortality risk in similar populations.

Keywords: firearms injury, postoperative mortality, war injury

Introductıon

The assessment of injury and mortality risk among trauma patients relies on prognostic indicators, such as the injury severity score (ISS) and the mechanism of injury (1-4). The ISS provides a validated numerical description of the overall severity when an injury is sustained by more than one body part; ISS has been successfully used for >40 years (1). Although the ISS is commonly used to classify all injuries, it is not a universally done. Moreover, the ISS has not been used to differentiate the risks associated with medical and surgical treatment. Methods to assess the severity and mechanisms of injuries sustained by children during conflict have also been developed (5).

The Glasgow coma scale (GCS) score at admission can be used to predict outcomes in cases of civilian gunshot to the head. In one report, 94% of patients with an initial GCS score between 3 and 5 died, whereas in another study, 70% of those with an initial GCS score between 6 and 8 died (6). Other research has confirmed that a low (≤8) GCS score at admission predicted poor outcomes in civilian patients (7). In another report of civilian gunshot injury to the head, it has been reported that factors, such as GCS score at admission, missile trajectory, surgery type, pupillary light reflex asymmetry, basal cistern patency, age, and intraventricular hemorrhage, were significantly associated with the outcomes (8).

International classification codes have also been used to assess patients following trauma. A multivariate approach using the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10), Australian Modification (AM) codes was shown to perform best for trauma assessment (9). In addition, using the ICD-9 clinical modification (CM) codes, it has been demonstrated that multilevel models may be helpful when measuring and explaining interhospital differences in classification of trauma patients (10). Currently, the ICD is the most commonly used tool worldwide for collecting mortality and morbidity data, particularly the ICD-9; however, ICD-10-AM diagnostic codes are frequently used for trauma assessment. However, there is still a need for estimating the risk associated with anesthesia in war-injury cases requiring surgery. In the current study, we implemented a single ICD coding system for all anesthetic procedures for identifying the factors affecting mortality among patients undergoing surgery because of war injury. Using this system, patients were grouped on the basis of similarities in the invasiveness and type of surgery. These groups were, in turn, consistent with the codes of ICD-10-AM, and could be used as a model for describing the mortality risk in this population. The model-predicted discharge status was analyzed to determine whether independent variables such as sex, age, and surgical group affect the mortality in our cohort.

Material and Methods

This was a prognostic, epidemiologic, retrospective comparative study (evidence level III) conducted between 2011 and 2014. A total of 1143 pediatric and adult patients who underwent surgery in our tertiary university hospital for wartime firearms injuries, and whose American Society of Anesthesiologists score was I–II were included in the current study; we evaluated the variables that affected their mortality (i.e., death or survival at discharge). Medical data were procured from the hospital information system using the Y24 diagnosis code of the ICD-10-AM, as published by the Communiqué on Health Practices in Turkey. We specifically procured the following data of each patient on the basis of surgical group: admission date, age, sex, number of procedures, duration of hospital stay, anesthetic procedure codes, surgical procedure codes, and discharge status (death or survival) (Fig. 1).

After admission, surgical patients underwent rapid assessment and preparation before their surgery; the duration between admission to the hospital and the occurrence of the injury could range from days to hours. We compared Health Insurance Institution (HII) surgical groups for their association with mortality and survival. The HII classification is a seven-tier system for determining anesthesia services and billing expenses on the basis of characteristics and invasiveness of the surgery; all patient data was derived from the following six classes of the surgical procedure and/or interventions: A2, A3, B, C, D, and E (Table 1), each with their respective list of procedures. These procedure codes were consistent with those used in the ICD-10-AM. None of the patients underwent any of the group A1 procedures.

Statistical analyses

Analysis was performed using the IBM SPSS software, Version 22.0 (IBM corp., Armonk, NY, USA). The descriptive statistics were used for numerical data and frequency distributions were used for categorical variables. The Kolmogorov–Smirnov normality test was applied. Because it revealed deviations from normality among the continuous variables, nonparametric tests were employed.

Differences between two independent groups, among more than two independent groups, and between two categorical variables were analyzed using the Mann–Whitney U-test, Kruskal–Wallis test, and chi-square test, respectively. Correlations between two independent continuous variables were also analyzed. A logistic regression analysis was used to determine the variables that might affect patient discharge status (11). A P-value < 0.05 was considered statistically significant.

Results

Overall, 1143 patients treated at our hospital between 2011 and 2014 were included in this study. Of these, 47 were excluded because they were classified either as missing (n = 5), other (n = 2), no change (n = 32), or as having rejected treatment (n = 8) because they were too small-sized groups to be analyzed. Therefore, 1096 patients were included in the analysis (Fig. 1). Table 2 summarizes the sample population's characteristics and the numbers of patients per surgical group. All patients had an American Society of Anesthesiologists score between I–II. The median duration of hospital stay was 12 (0–559) days, and the median patient age was 29 (2–77) years. The percentage of male patients was 91.1% of the sample population. Approximately, 89% of patients were discharged in good health, whereas 11% of patients died. The data of the number of surgeries each patient underwent and their distributions among the surgical groups is separately provided in Table 2.

Table 3 shows the relationships and differences between variables, including the number of surgical procedures, the surgical group (A2, B, C, D, and E), the age and sex of the patient, and the patient's discharge status. There was statistically significant difference between the duration of hospital stay and status of patient discharge ($p < 0.05$). The duration of hospital stay for patients discharged post healing was significantly longer than those who died. There was no statistically significant difference between patient age and patient discharge status ($p > 0.05$). There was no statistically significant difference between groups in terms of the number of surgeries, operation groups A3, B, and E, and the patient discharge status ($p > 0.05$); however, there was a statistically significant difference between operation groups A2, C, and D, sex, and the patient discharge status ($p < 0.05$). Accordingly, among the patients who underwent groups A2, C, and D surgeries, the ratios of patients discharged post healing were significantly lower ($p < 0.05$), higher ($p < 0.05$), and lower ($p < 0.05$), respectively, than those who died. Among male patients, the ratio of those discharged post healing was significantly higher than those who died, whereas among female patients, it was the opposite.

The surgical procedures performed in this study were classified under six categories. The most frequ-

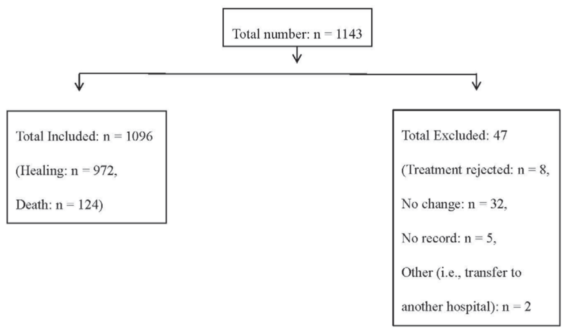

Figure 1: Flowchart for patient recruitment assessment and selection

ent procedures performed in this study population from each group were as follows: Group A included transplantation (n = 22; 64.7% of A2 procedures) and decompressive craniotomy (n = 5; 14.7%). Group C included open fractures (n = 112; 14.48% of C procedures), thoracostomy and chest tube replacement (n = 94; 12.16%), perforating eye injury (n = 66; 8.53%), complicated depression fracture (n = 51; 6.59%), fractured maxillae or mandibulae with open reduction and internal fixation (n = 44; 5.69%), jejunum/ileum enterotomy or enterostomy (n = 39; 5.04%), small bone fractures (n = 26; 3.36%), and small bone comminuted fractures (n = 25; 3.23%). Group D included soft tissue lacerations with deep foreign bodies (n = 114; 33.13% of D procedures) and exploratory laparotomies (n = 82; 23.83%). Group E included clinical monitoring, tube care, and catheter thoracostomy (n = 125; n = 33.33% of E procedures), long leg splints (n = 53; 14.13%), long-arm splints (n = 35; 9.33%), and short arm splints (n = 34; 9.06%).

Table 4 shows the relationships between variables and duration of hospital stay. There was a statistically significant difference between the number of surgeries and the duration of hospital stay ($p < 0.05$). Accordingly, patients who underwent ≥4 surgeries had a significantly longer duration of hospital stay than those who underwent 1, 2, or 3 surgeries. Similarly, the duration of hospital stay of patients who underwent only one surgery was significantly shorter than those who underwent ≥2 surgeries. There was no statistically significant difference between patient age and duration of hospital stay ($p > 0.05$). There was no statistically significant difference between A2 or B surgeries and the duration of hospital stay ($p > 0.05$), whereas there was significant difference between group A3, group C, group D, group E surgeries and duration of hospital stay, and sex and hospital stay ($p < 0.05$). Accordingly, the duration of hospital stay for patients who underwent A3, C, D, and E surgeries was significantly longer than that of patients who did not undergo these surgeries. The duration of hospital stay of female patients was significantly longer than that of male patients.

Table 1 Description of the surgical groups, surgical operation points, and the corresponding anesthesia procedure points published by the Health Insurance Institution in Turkey

Code	**Procedure name**	**Points for single surgical procedure**	**Corresponding anesthesia procedure points** (based on the single surgical points)	**Points for more than one surgical procedure**	**Corresponding anesthesia points for more than one surgical procedure** (based on more than one surgical points)*
550,130	Anesthesia A1 group (special surgeries and inter ventions)	3000–5000	1200	3000–5000	1400
550,140	Anesthesia group A2 (special surgeries and interventions)	2000–2999	750	2000–2999	900
550,150	Anesthesia group A3 (special surgeries and interventions)	900–1999	450	900–1999	540
550,160	Anesthesia group B (special surgeries and interventions)	500–899	210	500–899	250
550,170	Anesthesia C group (major surgeries and interventions)	300–499	120	300–499	144
550,180	Anesthesia D group (medium surgeries and interventions)	150–299	75	150–299	90
550,190	Anesthesia E group (minor surgeries and interventions)	0–149	50	1–149	60

The model using surgical groups (A2, A3, B, C, D, or E) as a predictor of patient discharge status demonstrated a statistically significant difference between the two outcomes (chi-square = 8.7) (Table 5). The coefficients for sex, age, and for surgical groups A2, C, and D remained significant in this model (Table 6). Specifically, mortality risk was 2.020 times higher for females than for males, and a 1-year increase in age corresponded to a 1.017 unit increase in mortality risk; however, the most marked increase in mortality was observed in group A2 patients (4.021 times more for patients in A2 group than those in non-A2 group). The mortality risk was lower in group C patients (0.625 times lower for the patients in C group than for those in non-C group). The mortality risk was also high for patients in D group (2.138 times higher for patients in D group than those in non-D group) ($p < 0.05$).

Various causes of death are summarized in table 7. There were miscellaneous causes of death; however, only the most frequent causes are presented in detail. The most common cause of death was sepsis (n = 20; 16.1%).

Discussion

Patients included in this study were predominantly young males who suffered firearm injuries during war and sequentially underwent surgery or other interventions at our tertiary university hospital between 2011 and 2014. The median age and proportion of males in our study were 29 (2–77) years and 91.1%, respectively; this was similar to the study by Belmont et al. (12) wherein they reported the mean age as 26.0 years among combatants, and the proportion of males as 98.8%.

Owens et al. (13) searched for the Joint Theater Trauma Registry of US service members who received treatment for wounds (International Classification of Diseases, Ninth Revision [ICD-9], codes 800–960) during Iraqi Freedom and Enduring Freedom. They reported that combat wounds were typically inflicted on the head (8%), eyes (6%), ears (3%), face (10%), neck (3%), thorax (6%), abdomen (11%), and extremities (54%). The authors concluded that the proportion of head and neck wounds in these two conflicts was higher (30%) than those inflicted during either

Table 2 Patient characteristics

	Median	**Min-Max**
Hospital stay (days)	12	0–559
Age	29	2–77
Sex	**N**	**%**
Male	998	91.1
Female	98	8.9
Discharge status	N	%
Healing (survival)	972	88.7
Death	124	11.3
Number of procedures	**N**	**%**
1	433	39.5
2	304	27.7
3	166	15.1
≥4	193	17.6
Operation group (class)	**N**	**%**
A2	33	3.0
A3	87	7.9
B	665	60.7
C	576	52.6
D	301	27.5
E	306	27.9

Table 3 Relationships and differences between variables and patient discharge status

		N	Median	Min.-Max.	Mann Whitney	p
Hospital stay (days)	Healing	972	12	0–559	−3.668	**0.000***
	Death	124	7.5	0–468		
Age	Healing	972	28	2–77	−1.231	0.218
	Death	124	29	5–75		
		Discharge status				
Number of procedures		**Healing**	**Death**	**Total**	**Chi-Square**	**p**
1	N	390	43	433	1.980	0.577
	%	40.1	34.7	39.5		
2	N	267	37	304		
	%	27.5	29.8	27.7		
3	N	148	18	166		
	%	15.2	14.5	15.1		
≥ 4	N	167	26	193		
	%	17.2	21.0	17.6		
A2 surgeries	N	23	10	33	12.227	**0.002****
	%	2.4	8.1	3.0		
A3 surgeries	N	79	8	87	0.423	0.516
	%	8.1	6.5	7.9		
B surgeries	N	588	77	665	0.118	0.731
	%	60.5	62.1	60.7		
C surgeries	N	526	50	576	8.390	**0.004****
	%	54.1	40.3	52.6		
D surgeries	N	251	50	301	11.606	**0.001****
	%	25.8	40.3	27.5		
E surgeries	N	270	36	306	0.086	0.769
	%	27.8	29.0	27.9		
Sex						
Male	N	893	105	998	6.992	**0.008****
	%	91.9	84.7	91.1		
Female	N	79	19	98		
	%	8.1	15.3	8.9		

*:p < 0.001 **:p < 0.01

World War II, the Korean War, or the Vietnam War (21%, 21.4%, and 16%, respectively). However, the proportion of thoracic wounds had decreased to 5.9% from those reported in World War II (13.9%), the Korean War (9.9), or the Vietnam War (13.4%) (13). Additionally, Kelly et al. (14) investigated the severity of injury and the causes of death caused by war injuries during the wars in Afghanistan (i.e., Operation Enduring Freedom) and Iraq (i.e., Operation Iraqi Freedom). They demonstrated that truncal hemorrhage was the leading cause of potentially survivable death. In contrast, we showed that the head and abdomen were the most common sites of fatal injury. Our study differs from that reports by Owens et al. and Kelly et al. because we included civilian casualties of individuals who injuries at multiple sites. Using the ICD-10-AM coding system and Y24 for firearm injuries, we observed the following injuries and injury combi-

Table 4 Relationships and differences between variables and length of hospital stay

		Hospital stay (days) N	Median	Min.–Max.	Kruskall Wallis	p
Number of procedures	1	433	8	0–286	−0.536	**0.000* Difference: between 1 and 2, 3, 4; between 4 and 2, 3**
	2	304	12	0–270		
	3	166	15.5	0–559		
	≥4	193	34	0–468		
		Hospital stay (days) N	**Median**	**Min.–Max.**	**Mann Whitney**	**p**
A2 surgeries	No	1063	12	0–559	−0.536	0.092
	Yes	33	14	1–104		
A3 surgeries	No	1009	11	0–559	−5.284	**0.000***
	Yes	87	22	0–328		
B surgeries	No	431	12	0–559	−0.036	0.972
	Yes	665	12	0–468		
C surgeries	No	520	10	0–345	−7.316	**0.000***
	Yes	576	16	0–559		
D surgeries	No	795	11	0–559	−4.729	**0.000***
	Yes	301	18	0–468		
E surgeries	No	790	11	0–262	−6.488	**0.000***
	Yes	306	20	0–559		
Sex	Male	998	12	0–559	−2.419	**0.016****
	Female	98	16	0–377		
				Hospital stay (days)		
Age	Spearman's Rho			−0.017		
	p			0.576		
	N			1096		

*:p < 0.001 **:p < 0.05

nations as being most likely to cause civilian deaths: head (24.2%); musculoskeletal (13.7%); abdomen and thorax (4.8%); abdomen and musculoskeletal (4%); thorax (1.6%); abdomen, thorax, and musculoskeletal (1.6%); head and face (1.6%); and head and musculoskeletal (1.6%). The leading cause of death observed in our research was sepsis. However, the injury sites and mortality causes that were majorly documented in our research showed that multiple sites of injury and multiple causes of death should be considered when assessing mortality from war injuries. Such an approach might present many combinations.

The ISS, for example, provides a valid numerical description of the overall severity of trauma among people who sustained injuries to more than one body part (1). Although the ISS is gaining popularity for the classification of all types of injuries, it is neither universally applied nor used to differentiate medical and surgical treatment risk. In the current study, we used groups defined by the Communiqué on Health Practices in Turkey on the basis of the invasiveness and characteristics of surgical procedures, considering them representatives of injury severity and an effective prognostic tool. Considering the injury site, 94 patients suffered thoracic injuries that required chest tube insertion and were included in group C. This group had a high survival rate compared with the other groups, suggesting that although the anatomic site of the injury might be enough to provide a true mortality risk score at admission, the surgical intervention contributes equally and might even alter the

Table 5 Model's Significance (Omnibus Test)

Dependent variable	Independent variable	−2 Log likelihood	Chi-Square	p
Discharge status Survival (healing) (0) Death (1)	sex Age A2 surgeries A3 surgeries B surgeries C surgeries D surgeries E surgeries	734.005	8.700	**0.000***

*:p < 0.001

Table 6 Coefficients of independent variables significantly affecting patient discharge status in the model

Variable	Exp (B)*	Std. Error	p	95% Confidence İnterval	
				Lower limit	Upper limit
Constant	0.055	0.342	**0.000********	-	-
Sex	2.020	0.283	**0.013****	1.160	3.517
Age	1.017	0.007	**0.021****	1.003	1.032
A2 surgeries	4.021	0.411	**0.001******	1.798	8.989
A3 surgeries	0.773	0.392	0.511	0.359	1.666
B surgeries	1.150	0.206	0.496	0.769	1.721
C surgeries	0.625	0.200	**0.019****	0.422	0.924
D surgeries	2.138	0.206	**0.000********	1.429	3.199
E surgeries	1.228	0.219	0.348	0.800	1.885

*: Odds ratio **: p < 0.05 ***:p < 0.01 ****:p < 0.001

Table 7 Causes of death

Cause	N	%
Sepsis	20	16.1
Head trauma	18	14.6
Hemorrhagic shock	8	6.4
MODS*	6	4.8
ARF**	5	4.0
Bile leakage, sepsis	4	3.2
Metabolic disorders	3	2.4
Miscellaneous	60	48.5
Total	124	100

Abbreviations: *MODS = Multiple organ dysfunction syndrome; **ARF = Acute renal failure score. Pannell et al. (5) reported that the average ISS was 12.3 ± 9.3 among pediatric cases who sustained war injuries (overall mortality = 8%), and that admission acidosis, coagulopathy, hypothermia, and female sex were associated with increased mortality. Similarly, mortality was higher among female patients than that in male patients in our study, and the overall mortality rate was 11.3%. Additionally, it is shown that the female death was higher by >2 folds in our study. Admission at our hospital after undergoing some form of surgical intervention at hospitals near the site at which trauma occurred affected the patients' classifications and ISS in this study. Therefore, data at admission may have been either incorrect or inappropriate for describing injury severity.

ICD coding requires training and as reported by Davie et al., this may restrict its use (15). After studying the accuracy of the coding using the ICD-10-AM system, it was found that 2% of cases were not coded with a principal injury diagnosis by a senior advisor in clinical coding, and that 14% of the principal injury diagnoses and 26% of the external codes were inaccurate. For countries intending to implement the ICD-10 or one of its variants, Davie et al. concluded that their results provided insights on key limitations of the ICD system and guidance on where training should be focused (15). In other research, Willis et al. (9) compared the performance of the ICD-based ISS with other mortality prediction tools using an Australian trauma registry, and showed that a multivariate approach using ICD-10-AM codes provided good results. Clark et al. (10) also demonstrated that multilevel models might be helpful regarding the measurement and explanation of inter-hospital differences among trauma patients classified using ICD-9-CM codes. Based on the outcomes of treatment of severely wounded patients during combat operations in Iraq and Afghanistan, Stojadinovic et al. (16) used a graph of variable associations to develop a representative model of clinical outcomes. DeCuypere et al. (17) showed that the St. Louis scale predicted death (score ≥ 5) accurately in 78% of intracranial pediatric gunshot wound cases, and that it was more useful as a survival predictor than as a death predictor. In our study, we used the Y24 diagnosis codes of the ICD-10-AM to categorize war injuries caused by firearms, and a model based on surgical group, age, and sex which significantly predicted the mortality rate in this population. Therefore, we conclude that the surgical group was a useful prognostic tool, including similar characteristics and invasiveness of the surgeries and representing the severity of injury for risk classification in the war injury cases, effectively predicting the discharge status of such patients. The significance of the coefficients associated with the surgical group and those associated with the mortality rates suggests that this model can be used to predict mortality in surgical war injuries cases. In addition to the surgical group, sex and age coefficients were also useful prognostic factors in this patient cohort.

The relationship between surgical groups A2, C, and D and discharge status was the major mortality-related finding in our study. Group A2 and D surgeries were found to be associated with high death risks, whereas group C surgeries were associated with low death risk or high survival rates. Thus, discharge status may depend on the features and type of surgery, which could be a surrogate for the severity of the war injury/characteristics and type of injury. In addition, survival was shown to be independent of the number of the surgeries, though a significant relationship existed between the duration of hospital stay and those undergoing ≥4 surgeries. The type of surgery can affect subsequent complications, particularly in groups A3, C, D, and E resulting in prolonged hospital stay. Similar to our results, the median duration of hospital stay post surgery for war-related colon injuries was reported between 22 and 43 days (range, 1–306) which increased linearly with the ISS for primary repair and primary anastomosis (18).

Limitations of this study include the potential bias introduced by the study being done at a single center, the lack of forensic details regarding the nature of the firearms injuries (e.g., gun caliber and range), and the lack of ISS data on admission. Logistic regression modeling in our study showed that classification by surgical group might help when estimating mortality risk and assessing the need for surgical care among patients with war injuries coded based on the ICD-10-AM. To ensure reliability, however, this model should be tested at different centers with similar study population.

Accurately predicting mortality for civilian surgical war-injury patients is important for planning their surgical management. It is important to note when interpreting our data that the population we studied differed from most populations where civilian firearms injuries are sustained in non-conflict (non-war) settings. Notably, there are clear differences in the risk factors and outcomes. Important and well-established prognostic tools for trauma the ISS, ICD, and the GCS often cannot be applied in war settings because of the need for specialists competent in their use or the complexity and type of trauma. As an alternative method of assessment, we showed that surgical procedure-based coding for surgical interventions and surgeries related to anesthetic procedures, consistent with the ICD-10-AM, could be helpful in such situations. We believe that our findings provide a new and easily applicable clinical approach for treating victims with various surgical firearm wounds. Additionally, our findings may help predict mortality risk in similar populations in the future.

Funding: This research did not receive any grants from funding agencies in the public, commercial, or not-for-profit sectors.

References

1. Baker SP, O'Neill B, Haddon Jr W, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma Acute Care Surg 1974;14:187-96.
2. Haider AH, Chang DC, Haut ER, Cornwell EE, 3rd, Efron DT. Mechanism of injury predicts patient mortality and impairment after blunt trauma. J Surg Res 2009;153:138-42.
3. Brown JB, Stassen NA, Bankey PE, Sangosanya AT, Cheng JD, Gestring ML. Mechanism of injury and special consideration criteria still matter: an evaluation of the National Trauma Triage Protocol. J Trauma Acute Care Surg 2011;70:38-44.
4. Newgard CD, Zive D, Holmes JF, Bulger EM, Staudenmayer K, Liao M, et al. A multisite assessment of the American College of Surgeons Committee on Trauma field triage decision scheme for identifying seriously injured children and adults. J Am Coll Surg 2011;213:709-21.
5. Pannell D, Poynter J, Wales PW, Tien H, Nathens AB, Shellington D. Factors affecting mortality of pediatric trauma patients encountered in Kandahar, Afghanistan. Can J Surg 2015;58:S141-5.
6. Aldrich EF, Eisenberg HM, Saydjari C, Foulkes MA, Jane JA, Marshall LF, et al. Predictors of mortality in severely head-injured patients with civilian gunshot wounds: a report from the NIH Traumatic Coma Data Bank. Surg Neurol 1992;38:418-23.
7. Ambrosi PB, Valença MM, Azevedo-Filho H. Prognostic factors in civilian gunshot wounds to the head: a series of 110 surgical patients and brief literature review. Neurosurg Rev 2012;35:429-43.
8. Aarabi B, Tofighi B, Kufera JA, Hadley J, Ahn ES, Cooper C, et al. Predictors of outcome in civilian gunshot wounds to the head. J Neurosurg 2014;120:1138-46.
9. Willis CD, Gabbe BJ, Jolley D, Harrison JE, Cameron PA. Predicting trauma patient mortality: ICD [or ICD-10-AM] versus AIS based approaches. ANZ J Surg 2010;80:802-6.
10. Clark DE, Hannan EL, Wu C. Predicting risk-adjusted mortality for trauma patients: logistic versus multilevel logistic models. J Am Coll Surg 2010;211:224-31.
11. Doornik JA, Hansen H. An omnibus test for univariate and multivariate normality. Oxf Bull Econ Stat 2008;70:927-39.
12. Belmont PJ Jr, McCriskin BJ, Sieg RN, Burks R, Schoenfeld AJ. Combat wounds in Iraq and Afghanistan from 2005 to 2009. J Trauma Acute Care Surg 2012;73:3-12.
13. Owens BD, Kragh JF Jr, Wenke JC, Macaitis J, Wade CE, Holcomb JB. Combat wounds in operation Iraqi Freedom and operation Enduring Freedom. J Trauma Acute Care Surg 2008;64:295-99.
14. Kelly JF, Ritenour AE, McLaughlin DF, Bagg KA, Apodaca AN, Mallak CT, et al. Injury severity and causes of death from Operation Iraqi Freedom and Operation Enduring Freedom: 2003–2004 versus 2006. J Trauma Acute Care Surg 2008;64:S21-7.
15. Davie G, Langley J, Samaranayaka A, Wetherspoon ME. Accuracy of injury coding under ICD-10-AM for New Zealand public hospital discharges. Inj Prev 2008;14:319-23.
16. Stojadinovic A, Eberhardt J, Brown TS, Hawksworth JS, Gage F, Tadaki DK, et al. Development of a Bayesian model to estimate health care outcomes in the severely wounded. J Multidiscip Healthc 2010;3:125-35.
17. DeCuypere M, Muhlbauer MS, Boop FA, Klimo P. Pediatric intracranial gunshot wounds: the Memphis experience. J Neurosurg Pediatr 2016;17:595-601.
18. Vertrees A, Wakefield M, Pickett C, Greer L, Wilson A, Gillern S, et al. Outcomes of primary repair and primary anastomosis in war-related colon injuries. J Trauma Acute Care Surg 2009;66:1286-91.